LCR METER

MODEL: LCR-815B

INSTRUCTION MANUAL

Distributed & Serviced by:
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CONTENTS

Section One
DESCRIPTION

Model LCR-815 impedance meter is a general purpose, easy to use, high reliability component test instrument. The parameters of an impedance element with high accuracy and at high speed. The LCR-815 meter measures capacitance, inductance, resistance and dissipation factor over a wide range at test frequency of 120Hz and 1KHz in a five terminal connection configuration between the component and the instrument. The measuring circuit for the device to be measured is capable of both parallel and series equivalent circuit measurements and the measured values are displayed on two three-full digits LED displays on the front panel.

The measuring range for capacitance is from 0.1PF to 19mF, inductance from 0.1UH to 1900H, and resistance from 1mΩ to 19mΩ. All of which are measured with a basic accuracy of 0.2% to 0.3% depending on test signal level, frequency and measuring equivalent circuit, and at a typical measuring speed of 200 millisecond.

Section Two
SPECIFICATIONS

Complete specifications of the LCR meter are given in TABLE 2-1. These specifications are the performance standards or limits against which instrument is tested. TABLE 2-2 lists general information. General information is not specifications but is typical characteristics as additional information for the operator.

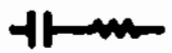
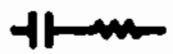
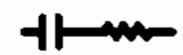
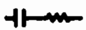
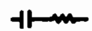
TABLE 2-1. Specifications (Sheet 1 of 2).

COMMON SPECIFICATIONS

Parameters Measured: C-D, L-D and R.
Display: 3 1/2 Digits, Max. Display 1900
Circuit Modes: Auto, Parallel and Series.
Measurement Circuit: Five-terminal Method.

Range Mode: Auto or Range Hold.
Measurement Frequencies:
120Hz+3%
1kHz+3%
Trigger: Internal, Manual or External.

C-D MEASUREMRNT

Range	C	120Hz 1kHz	1900pF 190.0pF	19.00nF 1900pF	190.0nF 19.00nF	1900nF 190.0nF	19.00µF 1900nF	19 0.0µF 19.00µF	1900µF 190.0µF	19.00mF 1900µF
	D	0.001 to 1.900, 1 range, common to all C range								
Test Signal Level *1			1V or 50mV					—		
			—			10µA	100µA	1mA	10mA	70mA
	AUTO		Same as  Mode				Same as  Mode			
C Accuracy *2 *3			0.2% + 2 count + 0.2pF					(Test signal level; 1V)		
			0.5%+ 3 counts	0.3% + 2 counts				(Test signal level; 50mV)		
			—				0.3% + 2 counts		0.5%+ 2 counts	1% +*4 2 counts
	AUTO		Same as  Mode				Same as  Mode			
D Accuracy *2			0.4% +(2+200/Cx) counts					(Test signal level; 1V)		
			—	0.6% +(2+1000/Cx)counts				(Test signal level; 50mV)		
			—				0.6% +(2+Cx/500) counts			1%+(5+ Cx/500) counts
	AUTO		Same as  Mode				Same as  Mode			

*1. Typical data, varies with value of D number of counts.
*2. +(% of reading+ counts+C). Cx is capacitance reasout in counts.
*3. C accuracies are applicable only when D value is less than 1.901. See Table 2~2 for C accuracies when D is more than 1.9000.
*4. 5% + 2 countd at 1kHz.
Accuracy applies over a temperature range of 23°C+/-5°C (at 0°C to 55°C Error doubles).

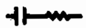
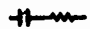
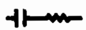
TABLE 2-1. Specifications (Sheet 2 of 2).

L-D MEASUREMRNT

Range	L	120Hz 1kHz	1900 µH 190.0µH	19.00mH 1900µH	190.0mH 19.00mH	1900mH 190.0mH	19.00H 1900mH	190.0H 19.00H	1900H 190.0H
	D	0.001 to 1.900, 1 range, common to all L range							
Test Signal Level *1			———			1V			
			70mA	10mA	1mA	100uA	10uA	———	
		AUTO	Same as  Mode				Same as  Mode		
L Accuracy *2 *3			———				0.3%+2counts	1%+2 counts	
			0.2% + 2 counts + 0.2uH					———	
		AUTO	Same as  Mode				Same as  Mode		
D Accuracy *2			———				0.6%+(3+Lx/500) counts	$1\%+(3+\frac{Lx}{500})$ counts	
			0.4% +(3 + 200/Lx) counts					———	
		AUTO	Same as  Mode				Same as  Mode		

*1. Typical data, varies with value of D number of counts.
*2. +(% of reading+ counts).
*3. L accuracies are applicable only when D value is then 1.901. See Table 2-2 for L accuracies when D is more than 1.9000.

R MEASUREMENT

Range	120Hz or 1kHz	1900mΩ	19.00Ω	190.0Ω	1900Ω	19.00kΩ	190.0kΩ	1900kΩ	19.00MΩ
Test Signal Level *1		————				1V			
		70mA	10mA	1mA	100μA	10μA	————		
	AUTO	Same as  Mode					Same as  Mode		
R Accuracy *2 *3		————				0.3%+2counts			
		0.2%+2 counts					————		
	AUTO	Same as  Mode					Same as  Mode		

*1. Typical data, varies with value of D number of counts.
*2. +(% of reading+ counts).
*3. R accuracies are applicable only when D value measured in L or C function is greater than 0.500. See Table 2-2 for R accuracies when Dis less than 0.501.

DC BLAS

Internal Source: 1.5V, 2.2V, 6V (Accuracy+5%)

External Source: Provision for external DC bias voltage of+30V maximum at binding posts on rear panel.

TABLE 2-2 (Sheet 1 of 3)

○ L-D/C-D accuracies when $D > 1.900$ and R accuracies when $D \leqslant 0.500$,
The following error factors should be added to accuracy specifications:

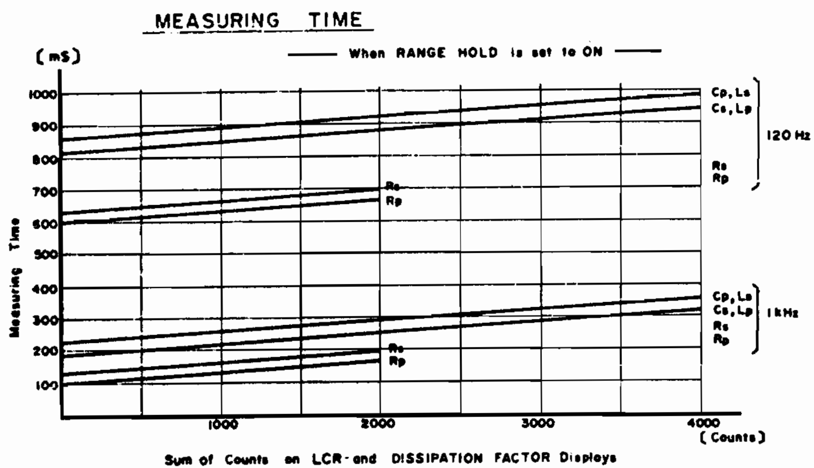
CIRCUIT MODE	ADDITIONAL ERROR
Parallel Capacitance	D/10 % of reading (Test Sig Level: 1V)
Series Capacitance	D/5 % of reading
Parallel Inductance Series Inductance	D/5 / of reading
Parallel Resistance Series Resistance	0.2/D % of reading

○ READING RATE — The period between the start of a measurement and the start of next measurement is equal to the measuring time plus 30 milliseconds hold time.

1KHz	C/L	220 – 260 mS
	R	120 – 160mS
120Hz	C/L	900mS
	R	700mS

TABLE 2-2 (Sheet 2 of 3)

○ MEASURING TIME — The period between start of a measurement and completion of the measurement is equal to measuring time when range hold is set to "ON" plus time required for autoranging. The following are typical times, a measurement of approximately 1000 counts on low loss components when range hold is set to "ON".



Time required for autoranging when range hold is set to "OFF".
1KHz — 180 x N (mS), 120 Hz — 670 x N (mS). Where N is the number of range stepped by autorange circuit.

TABLE 2-2 (Sheet 3 of 3)

- **TRIGGER** –
  When trigger switch is set to "INT" position, it triggers itself automatically at reading rate speed. When trigger switch is set to "EXT" position. It is triggered every time when manual button is depressed and released. Besides, it can be triggered by the trailing EDGE of a TTL level negative going pulse which applied to "EXT" trigger input connector on REAL PANEL. The negative pulse widthof trigger should be more than 20 μS.

- **WARM-UP TIME** – Approximately 20 minutes.

- **OPERATING TEMPERATURE** – 0°C TO 50°C

- **OPERATING HUMIDITY** – LESS THAN 95% AT 40°C

- **POWER SOURCE** – 100, 120, 220 and 240V AC +/- 10%, 48 to 66Hz

- **DIMENSIONS** – Approximately 310mmW x 100mmH x 395mmD

- **WEIGHT** – Approximately 5.5KG.

Section Three

PRECAUTIONS BEFORE OPERATING THE LCR METER

○ **UNPACKING THE LCR METER:**

The LCR meter is shipped from the factory after being fully inspected and tested. Upon receipt of the instrument, immediately unpack and inspect it for any damage which might have been sustained when in transportation. If any sign of damage is found, immediately notify the bearer and/or the dealer.

○ **POWER REQUIREMENTS:**

The LCR meter requires a power source of 100, 120, 220 or 240V AC +/- 10%, 48 to 66Hz single phase. Power cosumption is approximately 30 watts. Before turning the LCR meter power switch "ON" verify that the instrument is set to the voltage of the power supplied.

○ **SELECTION OPERATING VOLTAGE:**

1. Disconnect power cable and slide module window to left.
2. Pull "Fuse Pull" lever and rotate to left, this removes line fuse.
3. Select operation voltage by orienting PC board to position desired voltage on topleft side. Push board firmly back into module slot.
4. Rotate "Fuse Pull" lever back into normal position and re-insert fuse in holders. Read caution label to select correct fuse value.

○ **ENVIRONMENTS:**

The normal ambient temperature and humidity, range of this instrument is 0°C to 75°C, 95%. Operation of the instrument outside of this range may cause damage to the circuit.

Section Four
EXPLANATION OF FRONT PANEL

(1) **POWER ON/OFF SWITCH:**
Turn instrument on and set instrument ready for measurement.

(2) **OVER RANGE LAMP:**
This lamp is turned on if inductance, capacitance, resistance or dissipation factor measured is out of the range when RANGE HOLD (7) is set ON; and by selected CIRCUIT MODE (12) when RANGE HOLD (7) is OFF. When OUT OF RANGE lamp lights, either one or both displays will be blank or read 1999 counts.

(3) **LCR DISPLAY:**
Inductance, capacitance or reistance value including the decimal point and unit is displayed by this thre-full digit display. Display counts in the range between 0 and 1900 have meaning and number counts over this range are meaningless.

(4) **UNITS:** Indicates measurement units associated with LCR display.

(5) **DISSIPATION FACTOR DISPLAY:**
Value for dissipation factor is always displayed as a decimal. Dissipation factor measurement in the range of 0.000 to 1.900 can be measured with meaningly. Other dissipation factor values measured by the instrument do not have any meaning. This display will be blank, when number of counts for inductance (Ls) or capacitance (Cp) is less than 80 counts.

(6) **CIRCUIT MODE INDICATOR**: Led lamp illuminates to indicate the circuit being measured.

(7) **RANGE SWITCH:**

Setting this switch to "AUTO" which enables the instrument to make measurements in AUTORANGE mode. When range is set to "HOLD", range is held on the range which selected just prior to setting range to "AUTO". When range is in "AUTO" position, range is scaled down by one decade when changing test frequency from 120Hz to 1KHz, and scaled up by one decade when changing from 1KHz to 120Hz except in resistance measurement.

(8) **TEST LEVEL SELECTOR SWITCH:**

This switch is effective only in parallel capacitance measurement and permits selection of test voltage to be applied to sample 50 mVrms or 1Vrms. The 50 mV test voltage is generally utilized in semiconductor device measurements.

(9) **FREQUENCY SELECTRO SWITCH:**

Permits selection of frequency of test signal applied to sample either 120Hz or 1KHz.

(10) **TRIGGER SWITCH:**

This swtich selects trigger mode INT. or EXT. The INT trigger mode uses internal trigger which enables instrument to make repeated measurement automatically. In EXT trigger mode, triggering is performed by either operating trigger button manually, or by a trigger through EXT trigger input connector on rear panel.

(11) FUNCTION SWITCH:

This switch selects electrical circuit parameter to be measured with the instrument as follows:

FUNCTION	PARAMETERS MEASURED
L	INDUCTANCE AND DISSIPATION FACTOR
C	CAPACITANCE AND DISSIPATION FACTOR
R	RESISTANCE

(12) CIRCUIT MODE SELECTOR SWITCH:

Appropriate circuit mode for taking a measurement which is selected and set with this switch. A parallel equivalent circuit is selected when the switch is set at PARA position, and series equivalent circuit is selected when the switch is set at the SER position. The instrument also automatically selects the appropriate parallel or series equivalent circuit when switch is set to AUTO circuit mode position.

(13) MANUAL TRIGGER AND RESET SWITCH:

When this switch is pushed and released, it triggers a measurement cycle. The switch is normally used when trigger is set to EXT. But it also functions when trigger is set to INT. A measurement cycle is initiated when the trigger pushbutton is released. Holding the trigger pushbutton in its depressed position will hold the measurement. Releasing the button will initiate a measurement and permits the internal triggering to continue.

(14) GUARD TERMINAL:

This is connected to chassis ground of instrument and can be used as guard terminal for increasing accuracy in certain measurements.

(15) UNKNOWN TERMINAL:

CONSISTS OF FOUR TERMINAL:

High force terminal, high sense terminal, low force terminal and low sense terminal.

(16) C OFFSET ZERO ADJUSTMENT:

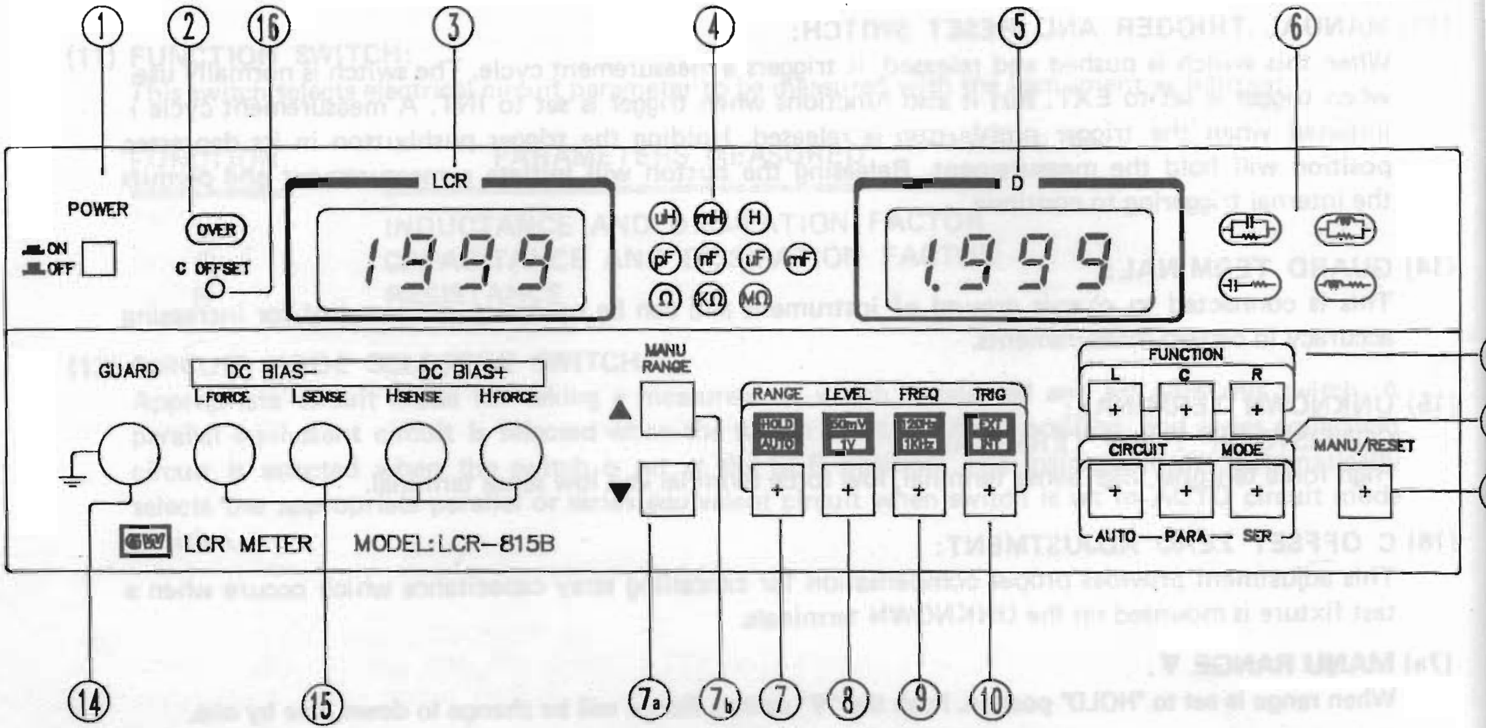
This adjustment provides proper compensation for cancelling stray capacitance which occure when a test fixture is mounted on the UNKNOWN terminals.

(7a) MANU RANGE ▼:

When range is set to "HOLD" postion. Push the "▼" switch. Range will be change to down, one by one.

(7b) MANU RANGE ▲:

When range is set to "HOLD" postion. Push the "▲" switch. Range will be change to up, one by one.



1
2
16
3
4
5
6
POWER
ON
OFF
OVER
C OFFSET
LCR
1999
uH mH H
pF nF uF mF
Ω KΩ MΩ
D
1.999
GUARD
DC BIAS−
DC BIAS+
LFORCE
LSENSE
HSENSE
HFORCE
MANU RANGE
RANGE
LEVEL
FREQ
TRIG
HOLD
AUTO
50mV
1V
120Hz
1KHz
EXT
INT
FUNCTION
L
C
R
CIRCUIT
MODE
MANU/RESET
AUTO — PARA — SER
LCR METER
MODEL:LCR-815B
14
15
7a
7b
7
8
9
10

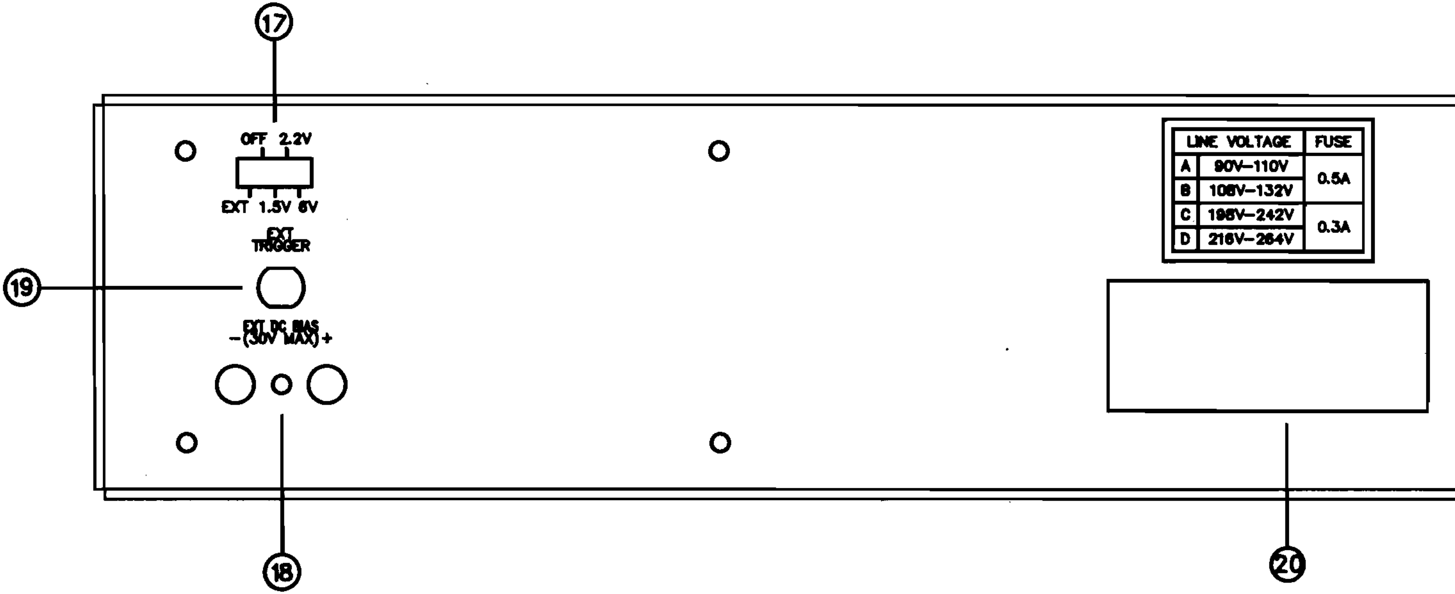
Section Five
EXPLANATION OF REAR PANEL

(17) DC BIAS SELECTOR SWITCH:
This switch permits selection of internal DC bias voltage applied to sample 1.5VDC, 2.2VDC, 6VDC or when switch is set to EXT which can be used to apply external bias voltage from rear DC bias input connectors. OFF position is selected when bias voltage is not necessary.

(18) DC BIAS VOLTAGE INPUT CONNECTORS:
External DC bias voltage can be applied to the sample up to the maximum voltage of plus 30V through the connectors.

(19) EXT TRIGGER CONNECTOR:
This connector is used for triggering the instrument by inputting a trigger signal from an external including a user designed triggering circuit. For external triggering, trigger switch on front panel is normally set to EXT position.

(20) AC POWER INPUT CONNECTOR:
Permits line voltage selection of 100VAC, 120VAC, 220VAC or 240VAC.


17
OFF 2.2V
EXT 1.5V 6V
EXT
TRIGGER
19
EXT DC BIAS
-(30V MAX)+
18
LINE VOLTAGE | FUSE
A 90V-110V
B 108V-132V
0.5A
C 198V-242V
D 216V-264V
0.3A
20

Section Six
GENERAL OPERATING INFORMATION

- **Connecting out:**
The unknown terminals consist of five connectors;
Hforce, Hsense, Lforce, Lsense and guard. These terminals are sometimes converted to a three terminal configuration including guard terminal. A four-terminal measurement configuration, which is useful for accurate low inductance, high capacitance or low resistance measurement, is also feasible. When converting to three terminals, shorting bars are attached to the instrument combine Hforce and Hsense terminals, and Lforce and Lsense terminals, respectively.

- **Test fixtures and leads:**
The LCR-815 has three kind of test fixtures and leads available. These are described in Table 6-1. The characteristics of the sample to be measured should determine which accessary should be selected. In a similar way to these available accessories, user built test fixtures or leads may be constructed for special measurement requirements.

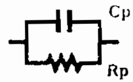
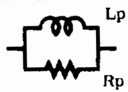
- **Measuring circuit modes:**
The circuit mode which treats and measures the unknown as a parallel capacitance is called the parallel capacitance mode, and in like manner, the other measuring modes are: series capacitance, parallel inductance, series inductance. Parallel resistance and series resistance.

TABLE 6-1 Test Fixture and Leads

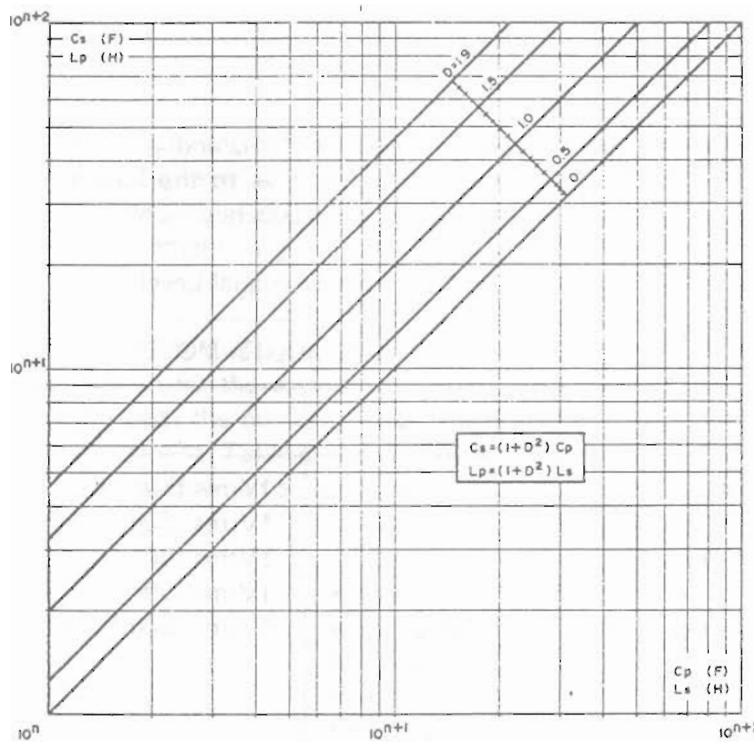
Accessory	Characteristics
LCR–03	These test-leads are especially useful for the measurement of low impedances (e.g. a low inductance – less than approx. 2H at 1kHz or 20H at 120Hz, a high capacitance – more than approx. 10nF at 1kHz or 100nF at 120Hz or low resistance – less than approx. 10kΩ). If the measuring sample is more than approx. 300μF at 1kHz or less than approx. 100μH at 1kHz, it is recommended that the respective potential leads and current leads should be twisted together.
LCR–02	These test-leads are particularly useful for measuring high impedances (e.g., an inductance of more than approx. 3mH at 1kHz or 30mH at 120Hz, a capacitance lower than approx. 10μF at 1kHz or 100μF at 120Hz, or a resistance more than approx. 20Ω). They are not intended to be used for accurate measurement of small capacitances less than approx. 100pF due to the residual capacitance of the leads.

○ Parameter values for a component measured in a parallel equivalent circuit and that measured in series equivalent circuit are different from each other. For example, the parallel capacitance of a given component is not equal to the series capacitance of that component. Figure 6-1 shown the relationships between parallel and series parameters for various values of D. Applicable diagrams and equations are given in the chart. For example, a parallel capacitance of 1000pF with a dissipation factor of 0.5, is equivalent to a series capacitance value of 1250pF at 1KHz. As shown in Figure 6-1, inductance or capacitance values for parallel and series equivalents are almost indentical when the dissipation factor is less than 0.01. The letter D in Figure 6-1 represents dissipation factor and is calculated by the equations presented in Table 6-2 for each circuit mode. The dissipation factor of a component always has the same dissipation factor at a given frequency for both parallel equivalent and series equivalent circuit. The reciprocal of the dissipation factor is quality factorand D is often represented as Tanθ which is the tangent of the dissipation angle(θ). Table 6-2 for example, a series inductance of 1000μH which has a dissipation factor of 0.5 at 1KHz has a series resistance of 3.14 ohms.

TABLE 6-2 Dissipation Factor Equations

Circuit Mode		Dissipation Factor	Conversion to other modes
Cp mode		$D = \frac{1}{2\pi fCpRp} \left(= \frac{1}{Q}\right)$	$Cs = (1 \quad D^2)Cp$, $Rs = \frac{D^2}{1 + D^2} \cdot Rp$
Cs mode		$D = 2\pi fCsRs \left(= \frac{1}{Q}\right)$	$Cp = \frac{1}{1 + D^2} Cs$, $Rp = \frac{1 + D^2}{D^2} \cdot Rs$
Lp mode		$D = \frac{2\pi fLp}{Rp} \left(= \frac{1}{Q}\right)$	$Ls = \frac{1}{1 + D^2} Lp$, $Rs = \frac{D^2}{1 + D^2} \cdot Rp$
Ls mode		$D = \frac{Rs}{2\pi fLs} \left(= \frac{1}{Q}\right)$	$Lp = (1 + D^2)Ls$, $Rp = \frac{1 + D^2}{D^2} \cdot Rs$

*f: Test signal frequency.



Where n stands for a free integer.

Figure 6-1 Conversion Between Parallel and Series Equivalents.

○ **Test signals:**

Two test signal frequencies are available. These are 120Hz and 1KHz sinusoidal waveforms which have a frequency accuracy of 3%. The typical voltage applies to the sample or current flowing though the sample is specified in Table 6-3 for both test signal frequency.

TABLE 6-3 Test Signal Level.

RANGE	CIRCUIT MODE					
	Ls	Lp	Cs	Cp	Rs	Rp
1	70mA rms	–	–	1Vrms (50mVrms)*	70mA rms	–
2	10mA rms	–	–	1Vrms (50mVrms)*	10mA rms	–
3	1mA rms	–	–	1Vrms (50mVrms)*	1mA rms	1V rms
4	100 A rms	1V rms	10 A rms	1Vrms (50mVrms)*	100 μA rms	1V rms
5	10 μA rms	1V rms	100 μA rms	1Vrms (50mVrms)*	10 μA rms	1V rms
6	–	1V rms	1 μA rms	–	–	1V rms
7	–	1V rms	10mA rms	–	–	1V rms
8	–	–	70mA rms	–	–	1V rms

*When Cp TEST SIG LEVEL is set to 50mV.

- **Measurement range:**
  Seven or eight range are available and the range is automatically selected for the sample value connected to the LCR-815. Four or five range, however, are used for measurement is series and parallel equivalent circuit modes, when the CIRCUIT MODE is set to AUTO, the LCR-815 will automatically select the circuit mode, range over all the measurement range.

- **Display:**
  The LCR-815 has two display, the LCR display and the DISSIPATION FACTOR display. The circuit mode indicator lamp is lit as assigned by the settings of FUNCTION and CIRCUIT MODE. The unit lamps light and read in conjuction with the numerical LCR display to their lift. The right side display is blanked durin g resistance measurement. Table 6-4 describes operator action to be taken when OVER lamp is lit, when the display is blanked, or when a minus display occurs.

TABLE 6-4 ANNUNCIATION DISPLAY MEANINGS
(Sheet 1 of 2).

DISPLAY	INDICATED CONDITION	ACTION
OVER	1. At least one of two displays esceeds 1999 counts. 2. Measured value for LP, Cs or Rp is less than about 80 count. Both display show 1999 count. In Rp mode, right display is always being blanked. 3. Range is held to one not specified as a measurable range for parallel or series circuit modes. When this occurs, unmerals of both display are blanked. Decimal point is still lit.	a. Set LCR-815 to: CIRCUIT MODE – AUTO RANGE – AUTO FREQ – 120Hz b. Try changing FUNCTION to L, C or R

TABLE 6-4 ANNUNCIATION DISPLAY MEANINGS
(Sheet 2 of 2).

DISPLAY IS BLANK	1. Right display is blanked during Rp or Rs measurement.	Normal operation
	2. Range is held to one not specified as measurable range for parallel or series circuit mode. OVER lamp is also lit. 3. Right display is blanked when measured value of inductance or capacitance is less than 80 counts. 4. Right display is blanked when Lp or Cs value exceeds 1999 counts. In this case, over lamp is lit.	a. Set LCR-815 to: CIRCUIT MODE – AUTO RANGE – AUTO FREQ – 120Hz b. Check that function is correct.
MINUT (-) IS DISPLAYED	1. Minus display sometimes occurs when sample having a value around zero is measured.	Zero counts display is meaningful when minus display repeatedly turn on and off.
	2. Sometimes a minus display occurs when a capacitor (or inductor) is measured in L (or C) FUNCTION.	Change to correct FUNCTION

Section Seven
APPLICATION

○ **COMPONENT MEASUREMENTS:**

1. Remove short bar connections between high terminals and between low terminals. Connect test fixture to unknown terminals.
2. Push power switch to on, check that trigger lamp turns on and off.
3. Set controls as follows:

   FREQ ....120Hz OR 1KHz
   DC BIAS ....OFF
   LEVEL 1V
   TRIG..........................INT
   FUNCTION...................L, C OR R
   CIRCUIT MODE ....AUTO
   RANGE.........................AUTO
4. Connect sample to be measured (L, C or R) on test fixture.
5. If internal DC bias is required, set DC bias switch to 1.5V, 2.2V or 6V. If not, OFF position should be selected.
6. Read measured valued on display.

NOTE AND CAUTION

1. Guard terminal is sometimes used in small capacitance measurements.
2. In Cp mode test level may be set to 1V for a more accurate measurement than that with 50mV test level.

3. DC bias application may only be used for capacitance measurement.
4. When over, minus or blank display occurs, see Table 5-4 for solution.
5. External DC bias through EXT bias connector must never exceed +30V.
6. It is usually best to set range switch to HOLD when measuring multiple samples having almost the same value.
7. Series resistance of electrolytic capacitors, inductors or transformers can be measured in Rs measurement mode. In these cases, the number of digits is sometimes reduced. On the other hand, resistance can, of course, be indirectly measured with the C or L function and calculated from one of the following equations:

   $Rs = D/wCs$ (Cs-D measurement)

   $Rs = wLs \cdot D$ (Ls-D measurement)

   $Rs = wLp \cdot [D/(1+D^2)]$ (Lp-D measurement)
8. Positive pole of electrolytic capacitor must be connected to high terminals as plus bias voltage is applied to high terminals with respect to low terminal.

○ **SEMICONDUCTOR DEVICE MEASUREMENTS:**

1. Remove shortin g bar connections between high terminals and between low terminals. Connect test leads or fixture to unknown terminals.
2. Push power switch to turn instrument on, verify that trigger lamp is turning on and off.
3. Set controls as follows:

   FREQ . . . . .1KHz FUNCTION. C

DC BIAS . . . . .OFF
LEVEL 50mV
TRIG. . . . . .INT
CIRCUIT MODE . . . . .PARA
RANGE. . . . . .AUTO

4. If necessary, apply DC bias voltage internally or externally at rear panel DC bias connectors.
5. Adjust capacitance offset adjustment trimmer for zero capacitance reading.
6. Connect semiconductor device to test lead or fixture. The following are examples of connections for the various parameters to be measured.
7. Read displayed values. Refer to Figure 7-1.

NOTE AND CAUTION:

1. Test leads or fixture may be designed for this measurement.
2. Circuit mode should not be set to AUTO or SER. Level must be in 50mV.
3. Never apply an external DC bias over +30V.
4. DC bias switch must be in EXT position during application of external DC bias at rear panel connectors.
5. External DC bias source should be stable with low noise.
6. It is impossible to measure junction capacitance when bias current flows through sample.
7. If test cable is used, it should be shielded.
8. It is recommended that range should be set to HOLD when measuring multiple samples those values are about the same.

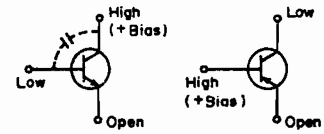
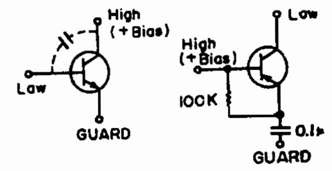
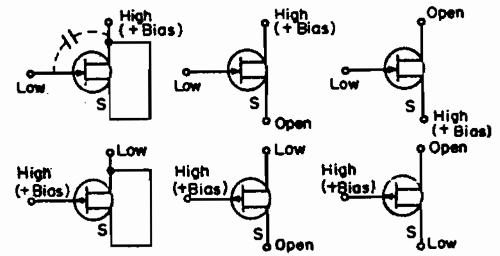
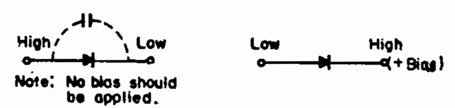
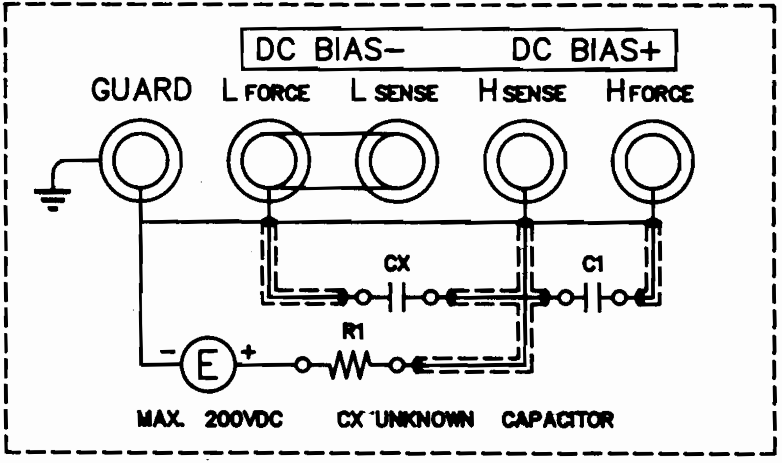
<table>
<tr><th>Parameter Measured</th><th>Connections to LCR-815</th></tr>
<tr><td>Base-collector junction
capacitance (Cob) -
Emitter current = 0</td><td>
</td></tr>
<tr><td>Base-collector junction
capacitance (Cre) -
Common emitter</td><td>
</td></tr>
<tr><td>FET gate capacitance</td><td>
</td></tr>
<tr><td>Diode junction capacitance
Note: Germanium diodes
sometimes cannot
be measured.</td><td>
</td></tr>
</table>

Figure 7—1

○ EXTERNAL DC VOLTAGE BIAS CIRCUITS

1. Connect external DC bias source as shown in diagram.



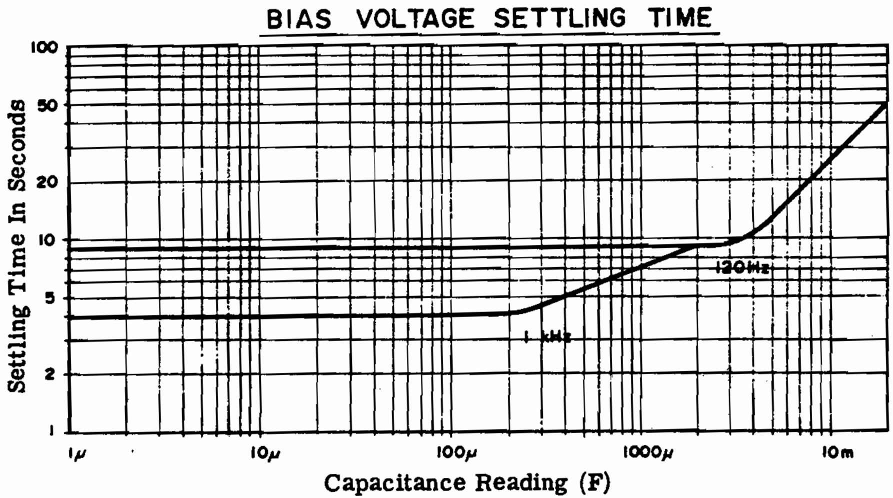
2. Minimum values for C1 and minimum values for R1 are given in table below:

Range	120Hz	1000pF	10.00nF	100.0nF	1000nF	10.00μF
	1kHz	100.0pF	1000pF	10.00nF	100.0nF	1000nF
Minimum C1 (F)	120Hz	0.01μF	0.1μF	1μF	10μF	100μF
	1kHz	0.01μF	0.01μF	0.1μF	1μF	10μF
Minimum R1 (Ω)		300kΩ	100kΩ	10kΩ	1kΩ	100Ω

3. Set controls as follows:

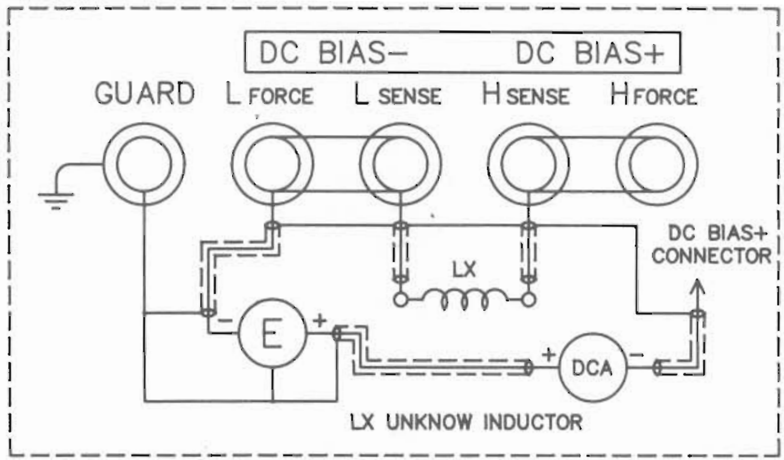
FUNCTION........................C
CIRCUIT MODE ....PARA
DC BIAS ....OFF
OTHER CONTROLS..................ANY SETTING

4. Read displayed value after allowing time for bias voltage to settle. Typical settling time are 6 to 7 seconds (120Hz), 2 to 3 secons (1KHz).



○ **USING CURRENT BIAS**

1. Connect DC power supply as shown below:



2. Set controls as follows:

FREQ ....120Hz or 1KHz
DC BIAS ....EXT
FUNCTION.........................L
CIRCUIT MODE ....PARA OR SER
RANGE............................HOLD

3. Recommended inductance ranges and maximum bias currents are:

RANGE	120Hz	1900μH	19.00mH	190.0mH	1900mH	19.00H	190.0H
	1KHz	190.0μH	1900μH	19.00mH	190.0mH	1900mH	19.00H
CIRCUIT MODE		SER		PARA			
CURRENT		52mA	40mA	13mA	52mA	40mA	13mA

CAUTION

1. DC bias over +30 volts must not be applied to external DC bias input connector.

Section Eight
UNUSUAL OPERATING INDICATIONS

INDICATION

1. Same sample sometimes shows quite different values between PARA and SER CIRCUIT MODE measurements.

WANT TO DO

Do not set CIRCUIT MODE to AUTO. Set CIRCUIT MODE to a PARA or SER setting that shows a valid display.

INDICATION

2. The decimanl point moves and measurement unit changes.

WANT TO DO

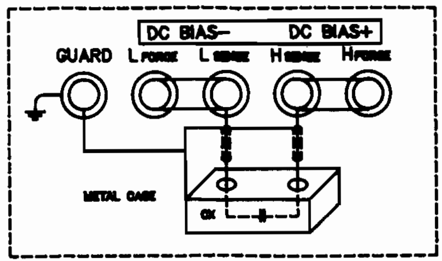
Set TRIG to EXT, push MANU button, set RANGE to HOLD and set TRIG to INT.

INDICATION

3. The displayed value fluctuates on minimum capacitance, miximum inductance or maximum resistance ranges in either PARA or SER circuit modes. Here are some of the reasons why this happens.
   A) A large size sample is being measured.
   B) A high voltage power line or similar exists near the LCR.
   C) The LCR and sample are connected together with relatively long, nonshielded cable.

WANT TO DO

1. Enclose sample in metal case. Connect case electrically to guard terminal as shown below:



2. Use hsielded cable for connection between sample and the instrument connect cable shield to guard.

4. When measurin g a low impedance (small inductance, resistance or high capacitance) measurement error as: ○ Residual impedance of test lead during two terminal measurement. ○ Mutual test lead induction between force leads and sense leads.	1. Use test leads in four-terminal configuration and measure. 2. Twist force leads together. Do the same with sense leads. 3. Attitional error is presented as W^2 LrCxX100% for C measurement. where = $2\pi f$, f = TEST FREQUENCY, Lr = RESIDUAL INDUCTANCE, Cx = UNKNOWN CAPACITANCE.
5. When measurement a high impedance measurement error is stray capactiance between H and L leads.	1. Use shielded cable for connection between sample and UNKNWON terminal. Connect outer conductor to GUARD.
6. Excessive measurement error.	1. Effect of low terminal capacitance with respect to ground. Sometimes the measurement can not be performed when a relatively large capacitance between L sense terminal and ground exists, allowable magnitude for the stray capacitance without additional error are: 120Hz . . . . .100nF 1kHz 1000PF

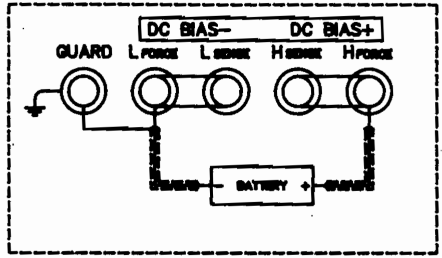
7. When a sample is measured in AUTO of CIR-CUIT MODE, the instrument repeats range selection and does not complete the measurement depending upon level of test current used. (Example, an iron core inductor)

2. Effect of high terminal capacitance with respect to ground. The stray capacitance will reduce test signal level applied to the sample measured during capacitance measurement. This decrease in signal level will not produce an additional error even when measurement signal level is reduced to a third of its norminal level. It is necessary, of course, that special care be taken to use the proper test signal level when a device is measured whose parameters may be affected by the test signal level. Display fluctuations may sometimes appear.

1. Try to determine the range that measures that sample properly by repeating HOLD an AUTO operation several time. Most operate is on HOLD mode for these cases.

8. Internal resistance of a battery can not be mreasured.

1. Connect sample battery as illustrated below:



2. Battery up to 30V are measured under no load conditions.
3. If battery voltage exceeds 4V, set DC bias to EXT and disconnect shorting bar from EXT DC bias connect on rear panel.
4. Since the internal resistance of a battery is relatively very low, use the four-terminal measurement configuration.

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